Nanocomposites and nanomaterials

Mechanism of conductivity of nanocomposites based on porous silicon with Nafion and TiO_2 inclusions and surface palladium films.

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The membrane electrode block is most often used in a portable fuel cell. Such block contains a proton conducting membrane from Nafion perforated polymer [1, 2]. One of the disadvantages of this material is its incompatibility with the microelectronic technology. Another promising class of materials for the development of membrane electrode block is a composites based on porous silicon. The filling of silicon mesopores by material with ionic conductivity will provide reinforced solid electrolyte. As the mesoporous silicon has also high resistance, it allows isolating a cathode and an anode in the membrane electrode block. Combining different porous layers (two electrodes and membrane) in a single silicon wafer will yield a monolithic membrane electrode block with enhanced reliability.

The present work describes the results of such an investigation in which the conductivity of nanocomposite based on porous silicon with Nafion/TiO_2 inclusions and nanostructured surface palladium films have been studied under H_2O adsorption. The morphology of Nafion/TiO_2 and Pd/Nafion/TiO_2 surface was characterised by scanning electron microscopy (SEM) and atomic force microscopy (AFM). Palladium layers were deposited using the magnetron deposition technique at room temperature.

As a result our observations indicate that nanostructured palladium films on Nafion/TiO_2 surface lead to enhanced proton conductivity depends on the presence of TiO_2. Mechanisms of conductivity of nanostructured composites of Nafion/TiO_2 and Pd/Nafion/TiO_2 have been proposed.

1. *J. Zeng, B. He, K. Lamb, R. D. Marco, P. K. Shenc, and S. P. Jiang,* Phosphoric acid functionalized pre-sintered meso-silica for high temperature proton exchange membrane fuel cells // Chem. Commun., — 2013, — v. 49, — No 41, — pp. 4655–4657

2. *S. J. Hamrock and M. A. Yandrasits,* Proton exchange membranes for fuel cell applications *// J. Macromol. Sci. C: Polym. Rev., — 2006, — v. 46, — pp. 219–244*